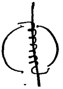
Francis R. Upton Student Notebook

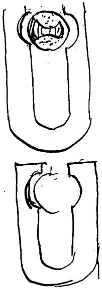
This notebook was used by Upton in June and July 1878 while he was a student of Hermann von Helmoltz. The book contains notes in German about Helmholtz's lectures on electricity and light. The notes are often accompanied by drawings and calculations. The front cover is labeled "E Helmoltz Upton 26/6 78." The pages are unnumbered. Approximately 50 pages have been used.

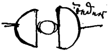
V~ 7 6 Juni

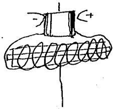
Lo

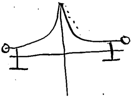
X-E6298

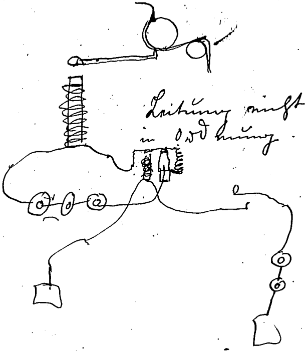








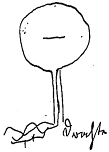



Leitung nicht
in Ordnung

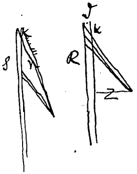
June 29

Wenn keine Magnet Nadel

Helmholtz' Tangent Boussole


Drähte entfernt

$\frac{e f'}{r_1^2}$ e Dichtigkeit
f' Fläche



$$\frac{e f'}{r_1^2} - \frac{e f''}{r_{11}^2}$$

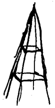
$$\frac{K}{\vartheta} = \frac{R}{Z}$$

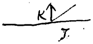
$$K =$$

$$\varepsilon K 2\pi R = \frac{\varepsilon 2\pi R^2 \vartheta}{Z}$$

$\varepsilon \vartheta = \mu$
Magnet Moment

$$\text{Kraft} = \frac{2\pi R^2 \mu}{\cancel{Z}} \frac{\cancel{Z}}{(\sqrt{Z^2 + R^2})^3}$$





$K = \frac{2\pi\mu}{R}$ Z ~~K~~ R.

$= \frac{2\pi J}{R}$ Anziehende Kraft.

J hor. Kraft im Maße.

$\tan\alpha = \frac{K}{J} = \frac{2\pi J}{RJ}$

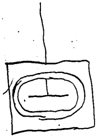
im absoluten Maße.

ganz genau mit Chemische Zersetzung in Verhältniß

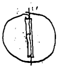
Nadel muß kurz

Tangent 3 Meter

3000 ÷ 50 ÷ 60



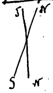
~~Tangentenb~~ sin Bussole



$J k \mu = T \sin\alpha \mu$

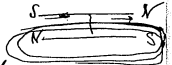
nicht so gut als Tan

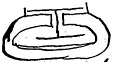
July 1



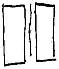
Läßt sich so zu stellen. Schwer genau parallel

Man kann bei starken A
alle ungünstiges empfindlich Luftströmen

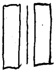




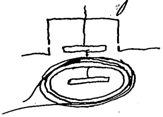
Die Kraft fühlen sehr oft.



Er magnet.
und anzieht.
wenn zu empfindlich
zu beseitigen
magnet!



~~Du Bois~~
Du Bois Reymond



$$\frac{\mathcal{E}\mathcal{E}}{r^2} = k = \frac{m\cdot(V_1 - V_0)}{t_1 - t_0}$$

$$\frac{\mathcal{E}}{r} = \sqrt{k} = \sqrt{\frac{m\,v}{s}}$$

$$v = \cancel{}\ \cancel{}\ \cancel{\frac{s}{t}} - \frac{S}{t}$$

$$\frac{\mathcal{E}}{r} = \sqrt{k} = \frac{1}{t}\sqrt{m\,S}$$

$$\mathcal{E} = \frac{r}{t}\sqrt{m\,S}$$

Wenn flie. Strom
durch Draht

$$\mathcal{E} = \mathcal{J}\,t$$

$$\mathcal{J} = \frac{r}{t^2}\sqrt{m\,S}$$

nach. Mag. Moment

$$\cancel{\ell\mu}\quad i = \frac{\mu}{\pi R^2}$$

Magnet — Moment =
Quantum X Abstand

$$\mu = \qquad \ell = \text{Länge}$$

$$i = \frac{\ell}{\pi R^2}\cdot\frac{r}{t^2}\sqrt{m\,S}$$

$$\mathcal{E} = \frac{r}{t^2}\sqrt{m\,S}$$

$$i = \frac{\ell}{\pi \ell^2}\cdot\frac{\ell}{t^2}\sqrt{m\,S}$$

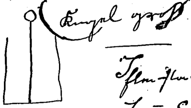
$$= \frac{\cancel{\ell}'}{t}\sqrt{m\,S}$$

$$J_e = \frac{r}{t}\,i \qquad \text{Weber.}$$

Grösse eine Geschwindigkeit.

Man kann mit Reibung fla. kleine Quantum Potential gross Leydener Flasche durch Flüssigkeit ~~ab~~ lan langsamer zu entladen. Man macht den Vers.

Weber und Kohlrausch



[illegible]

$$J_e = c\,i_m$$

$$c = 311{,}130{,}000\ \frac{\text{Mt}}{\text{Sec}}$$

Weber $c\sqrt{2}$

[illegible] Winkel grösse

$(2\cos\varepsilon$ ·

—— [illegible] dynamischen [illegible]

William Thomson

282.000 000

British Association

~~Max~~ Maxwell 288.000 000

Man kann im Ganzen feststellen

[illegible] die Widerstände

300 000 000 : 1 zu messen

Chemische Methoden:

Electrolytisches Maß - ~~[illegible]~~ Weber

$$\frac{1 \text{ Cub cent } OH_2}{1'' \text{ Minute}} \quad , \quad 0.9534 \frac{\sqrt{\text{mgr}}\,\text{Mm}}{\text{Sec}}$$

$$J = \frac{1\sqrt{\text{mgr}}\,\text{mm}}{\text{Sec}}$$ zersetzt in Secunde

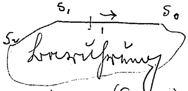
= 0.0092705 Bunsen

= 0.009239 Joule

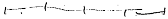
Kirchhoffsches Gesetz Ohm

$iw = (S_1 - S_0)$

Quantität Ströme ~~e~~ abhängt von Temp

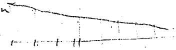


$$i w_1 = (S_1 - S_0) - a_1$$
$$i w_2 = (S_2 - S_1) - a_2$$
$$i w_3 = (S_0 - S_2) - a_3$$
$$i\,(\cancel{\Phi}\,\Sigma(w)) = -\Sigma(a)$$
$$i = \frac{\Sigma(a)}{\Sigma(w)}$$

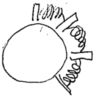


$$i\frac{w}{n} = S_1 - S_2 = \frac{S_1 - S_0}{n}$$

ſo man kann mit einem Grad e Linie repräſentiren



Dr Siemens Meilen Telegraphendraht



1 Element durch 9 Meilen

2 " " 18 1

3 " " 27

das ſelbe Strom

27

1

1/3 Ausſchlag

18

1

1/2

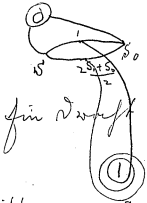
$$J = \frac{A}{W} \qquad A = WJ = WJ_1 + wJ_1$$

$$J_1 = \frac{A}{W+w} \qquad W(J - J_1) = wJ_1$$

$$\frac{W}{w} = \frac{J_1}{J - J_1}$$

Dr Geſchwindigkeit. Elementen ändern
ſich auch wieder

Nicht Strom oder wenn ein Strom iſt oder nicht da iſt.



$$i_1 w_1 = S_1 - S_0$$
$$i_2 w_2 = S_1 - S_0$$

Ein Draht ſollbiegt $\frac{S_1 + S_0}{2}$

kein Strom

Differenz $\frac{S_1 - S_0}{2}$

$$\frac{S_1 - S_2}{S_2 - S_0} = \frac{W_{12}}{W_{20}}$$

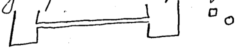
July 3 $J = \frac{\Sigma A}{\Sigma w}$

Etalon von Jacobi

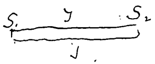
Ohm Weber Siemens

Praktisch leicht zu finden. Nicht schwer

Widerstand



1,1, 2 5 10 10 20. 50 100 &c



$W = \frac{\text{Länge}}{\text{Durchschnitt}} = \frac{L}{Q}$

K = Leitungsvermögen

$W = \frac{L}{KQ}$

Leitungsvermögen Elec und Wärme ähnlich

Ag	100
Cu	77.43
Au	55.91
Al	33.76
Zn	27.39
	23.10
Cd	14.44
Fe	10.53
Pt	1.63
Bi	
Graphit	0.0693

[illegible] Cu
Selen Fe
[illegible]

NO_3H 29.7 = 7330 10^{-8} Hg

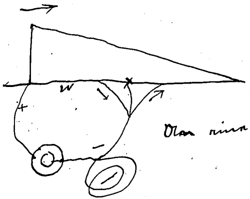
HCl 18.3% = 7174

H_2SO_4 30,4 = 6914

Tabellen W

Kohlrausch ~~Lati~~: Zusammengesetzt aus die verschiedenen Leitungsvermögen ~~d~~

Vergleichung elektromotorische Kräfte

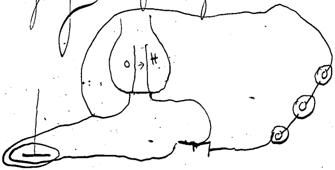


Oder einen Stelle

$$J_w = S_1 S_0 = {}'A$$

$$\frac{B}{W} w \;//\; \frac{B}{'A} = \frac{W}{w}$$

July 6 Polarization.

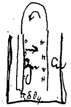


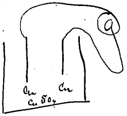
O → H

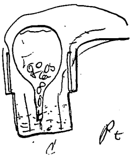
Polar

O ← H

Elec. Motor Kraft, kein Resultat erhalt 2.03, 1.7 D



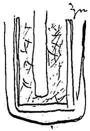




Grove 1.7 D. mit Pt

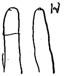
Bunsen mit C

Pt billiger # nicht so viel NH_4O_4



July 8

Palladium Polen o



Versuchen

Leitungs Körper warm

Grosse fla Flüssigkeit erhitz.

Lenz

und Entdecker Me. W-Eq Joule

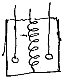
Strom Intensität

Wärme Entwickelung J^2

Drähte verschiedene Metall

Wärme zu W-

Calorimeter



Thermometer man kann Flamme hinein tauchen

$\Theta J = J^2 w$

$= J \frac{A}{W} w$

$J = \frac{E}{W}$ $J = g^{425}$ mk,

W die Kette

wenn Wärme von Gesammte

$w = W$

$\Theta_w Jt = JAt$

A = Electromotor Kraft

t = Zeit

Chem. Verwandschaft der Strom in selbe Richtung

Metal brennen in Cl.

Die — der Metal desto grösser Elec-K.

K

Hg Na

Z

Rb

Cu

Ag

~~Pt~~

NO_2

Grove Zn NO_2

auftritt

Zn — Cu 1.

Zn NO_2 1.7

Immer ~~das~~ die selbe Wärme Menge

von brennen

H - O. Losstützen wenn zusammen

kommen Geschwindigkeit ~~zum~~ Wärme

Wo die Favre und Silberman

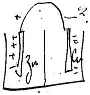
$\Theta_w J t = J A t$ = gleich W-M- durch chemischen Process.

$q J t = Q$ = Quantum Zn das eintritt.

Elektromotorische Kraft proportional zum W-M- unabhängig von

für Zn einen K, Na,

1 gramm H	
K	~~272.4~~
Na	2724
Zn	40524
Fe	43741
Pb	54430
~~Pt~~	57216
Cu	62591
Ag	79042
NO_2	81.00



$\underset{+}{Cu}$ ~~H~~ Bestandtheil;

$\leftarrow SO_4 \underset{+}{Zn} \rightarrow \leftarrow SO_4 \underset{+}{Cu} \rightarrow$

Elektron am Atom.

Neutral plus Neutral.

~~+~~ — Atom mit $\mp$ Strom

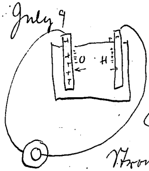
+ Kathode

(Zn) − (Cu) ~~Aequivalent~~ Aequivalent

$(Zn) - (Cu) + (P_Z - P_{Cu})$

Wird unterstützt durch Potential.

July 9

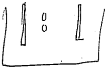


nach Strom
+H am einen Pol
−O " ~~+~~
Condensator mit einer
Molecülen gespannt

Strom entsprechend Ladung
Condensators

Gal. Element von ersten Starken
Strom Atmosphären ~~Tausen~~ f. O

kann H weg nehmen



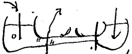
Wie Metal ~~aus~~ im innern

Palladium
1 Vol. Palladium 936 H nimmt.

Rein 12.38 Sp. G. mit H 11.79

Das H muss 1.78 – 1.98 Sp G
H wie Metal. Wie zu Metall
condensirt.

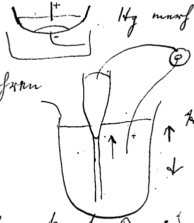
Cu. Ag. wie schwarzes Pulver
" "
Ganz Root Giesse.


?

Wasserstoff geht durch Pt

Arbeit $(H)_{\cancel{Pt}} - (O)_{\cancel{Pt}} = \cancel{p}P_- + \cancel{p}P_+ \quad P_- = -P_2$
$= P_1 - P_2$

Arbeit von H_2O H O ~~trennen~~
Die Reibung flu. im Draht.

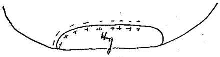


Hg nach kugel förmig

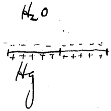
Rohren

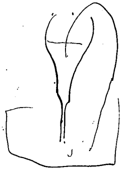
Hg zurück presse
↑
↓ " ↓

Umgekehrt



Geladene Fläche





~~Gebunden~~ Geschlossen an Hg ausfließen

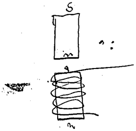
Lippmann Electrometer

Erhaltung der Kraft hält' aber so.

$J^2 w t = J A t$

$J^2 w$ = Arbeit

Strom kann Arbeit in Maschine.



$\therefore\ -J\,dJ + J^2 w t = J A t$

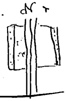
$J w = A + \frac{dJ}{t}$

July 10

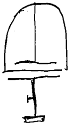
$\alpha J + (A J = J^2 W) - J \frac{dP}{t}$

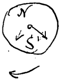
$\alpha J = -J \frac{dP}{t} \qquad \alpha = \frac{dP}{t}$

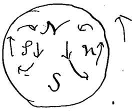
Faraday



Erstes Phänomen Arago

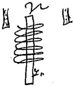




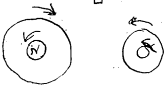


Immer der Arbeit den Magnet in Ruhe zu bringen

Spiral

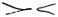


Strom unterbrechung

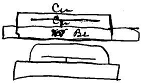


umgekehrt ebenso

Licht

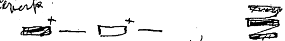


Thermo Elec



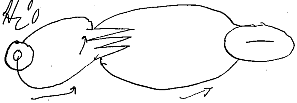
Bi Ni Pd Pt Cu Hg Pb Sn Ir Au
Ag Zn Cd Fe As Sb Te höhere Temp

Peltier

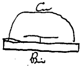


Sound heißen Kugel. Ziemlich
[illegible] zu erwärmen für Strahlen

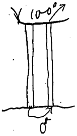
Polarisation der Volta Strom durch
July 15 Thermo Volta Zersetzung von
H_2O



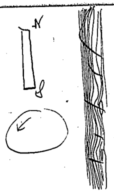
Wirkung der Volta entgegengesetzt



Sir William Thomson
Metall Elec nimmt Wärme mit,



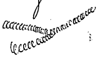
Cu + Elec mit führt Wärme
Fe − " " " Wärme



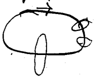
𝔄 A A A A 𝔄

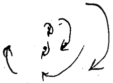
$iAL = J^2 w + Jp$ Wärme Chem

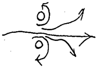
Ursache ein Strom Spannung
zustand Medium



Faraday



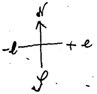




Äther Kraft Linien
sich zu verkürzen
strebt.

Maxwell

Äther Dielektrizi
Licht Äther muß das füllen



311,130 Kilomet.

Kette elec. Magn. nach einander

als ob solche Kraft
Zöllner ~~wird~~
Gravitation kein besser als New-
ton
Million Weber

e ε

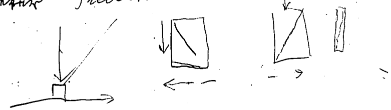
$\frac{e\varepsilon}{r^2}$ nimmt an

$\frac{e\varepsilon}{r^2}\left(1-\frac{1}{c^2}\right)\left[\dot{\rho}^2 - 2r\ddot{\rho}\right]\}$

Kraft von Beschleunigung das
Geschwindigkeit

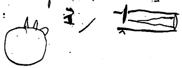
Licht

Olymp. . Zeit braucht . Planeten-
Jupiter Occultation



$\frac{2\pi R}{Jahr} = v$ Durchgänge Venus

Encke 41000 deutsche Meilen / Sec
Hansen 39700
Fizeau 42219 313274 . 3 Kilo
[illegible] 2 ~~Fizeau~~ Cornu 298500



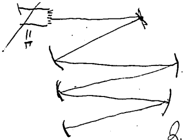
8633 Mt

Cornu
20000 Sec in Alle

Meilen

Rad 720 Zähne
12,6 mal in Sec
9042 zwischen Zeit
18000

Weber 311130 km Elektricität
Maxwell 288000 " "

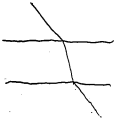


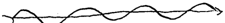
700 800 Umdrehung in Sec.

Dichtere Medium
langsamer als.

Zu unterscheiden [illegible]

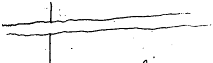
Licht übergehen in andere
Form der Bewegung z.B. Wärme
Interferenz





Transversale Schwingung

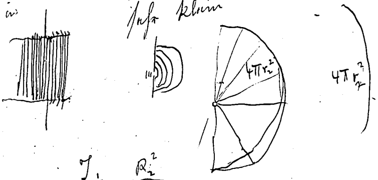
Strahl



Schall sehr Tön mehr in grade Linien

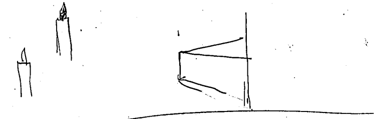
Wenn Öffnung sehr breit gegen Wellenlänge Fortpflanzung sehr stark.

in sehr klein

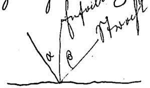

4πr_2^2
4πr_2^2

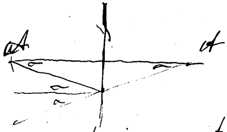
$$\frac{I_1}{I_2} = \frac{R_2^2}{R_1^2}$$

Messung Bouguer.

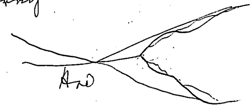


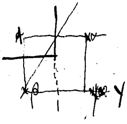
Spiegelung


einfallsloth
Strahl
α
β

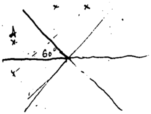


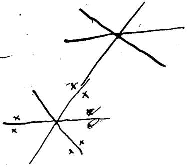
Alle Strahlen kommen von ~~A~~ A wie von A' betrachtet.





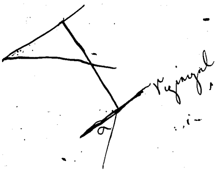
A Spiegelbild α
β β
β — γ
α — γ

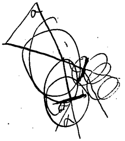


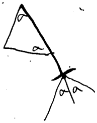


Prisma

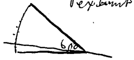
Heliostat

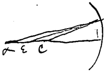




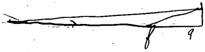


Sextant





Strecke vom Spiegel.
sehr kleinen Stücke



$\frac{x}{f} = \varepsilon$

$\frac{x}{g} = \eta = 2\omega - \varepsilon$

$x = R\omega$

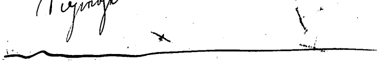
$\varepsilon - (-\eta) = \varepsilon + \eta = 2\omega$

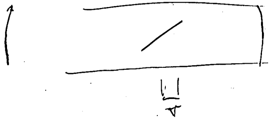
$\frac{x}{g} = \frac{2x}{R} - \frac{x}{f}$

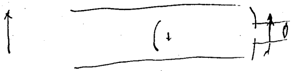
$\frac{1}{f} + \frac{1}{g} = \frac{2}{R}$.

f =

Spiegel mit Calcium Licht







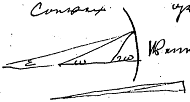
$$\frac{1}{f}+\frac{1}{g}=\frac{2}{R}=-\frac{1}{F}$$

Dieſes $\frac{1}{f}+\frac{1}{g}=\frac{1}{F}$ macht eine Lampe

Concav Brennpunkt vor dem Spiegel. Convex hinter dem Spiegel

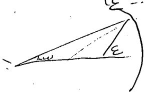
Concav vermindert Divergenz

Convex erhöht



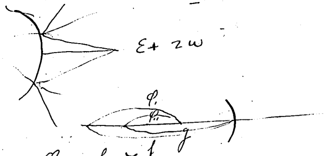
Wenn klein

$(\varepsilon -- 2\omega) --$



$(\varepsilon - 2\omega)$ Bild hinter Spiegel

$\varepsilon - 2\omega = \overset{+}{\underset{-}{0}}$



$\varepsilon + 2\omega$

$\varphi_I = f - F$

$\varphi_{II} = g - F$

$gF + fF - gf = 0$

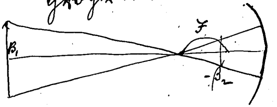
$\varphi_I \varphi_{II} = fg - Ff - gF + F^2$

$\varphi_{II} = \frac{F^2}{\varphi_I}$

$p_1 = \frac{\infty}{0}$ $\varphi_{II} = \frac{F^2}{\varphi_I}$ einfach

---

Grösse der Bilder haben wir folgende Gesetz: Gegenstand abstand bezeichnet

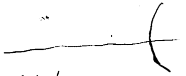


$$\frac{\beta_1}{-\beta_2} = \frac{\varphi_1 - F}{F - \varphi_{II}} = \frac{\varphi_1(\varphi_1 - F)}{F\varphi_1 - (\varphi_1\varphi_{II}) = F^2}$$

$$= \frac{\varphi_1(\varphi_1 - F)}{F(\varphi_1 - F)} = \frac{\varphi_1}{F} = \frac{F}{\varphi_{II}}$$

$$-\frac{\beta_1}{\beta_2} = \frac{F}{\varphi_{II}}$$

Grösse



[illegible]

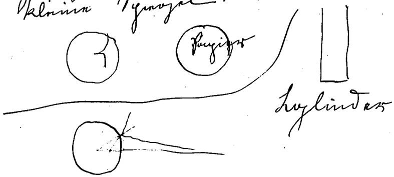
Bild hinter des Spiegels.

Hergestellt $\varphi_I \varphi_{II} = F_2$

$$-\frac{\beta_I}{\beta_{II}} = \frac{\varphi_I}{F_I} = \frac{F}{\varphi_{II}}$$

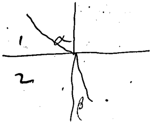
φ_{II} bezeichnet Entfernung Netzhaut.

Gesetze so weit anwendend und für kleine Spiegel.

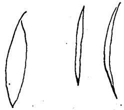


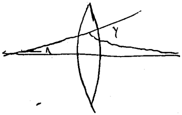
~~Der~~ Brechung

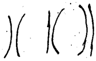
$$\frac{\sin \alpha}{\sin \beta} = n_2$$

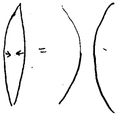


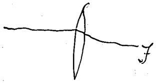
$$n_1 \sin \alpha = n_2 \sin \beta$$

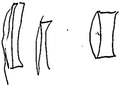


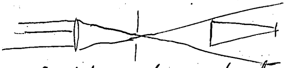






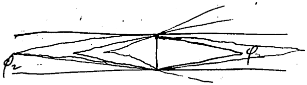




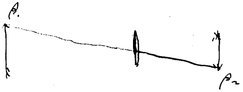


Could not understand what he said

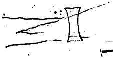
~~Keplersche~~ Fernrohr


φ_2
φ_1

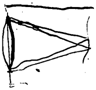
$$\varphi_1 \varphi_2 = F^2$$

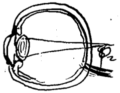

β_1
β_2

$$\frac{\beta_1}{\beta_2} = \frac{\varphi_1}{F} = \frac{F}{\varphi_2}$$



Brennpunkt — konvex.

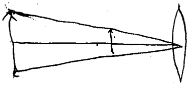


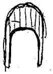


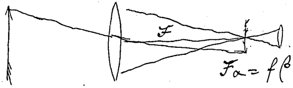
Man muß nach Gauß zwei Brennweiten $\varphi_1 \varphi_2 = F_1 F_1$

Man kann
Akkomodation
kurz sichten die Fernsicht entfernt

Alt verlorene Akkomodation.
Lorgnon



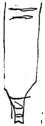




$F\alpha = f\beta$ $\frac{\beta}{\alpha} = \frac{F}{F}$

Man muß Augen wie von entfernten Objekt stellen

Objektiv muß wechseln mit



Man muß von viele Linse zu suchen

Immersions Objektiv

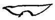
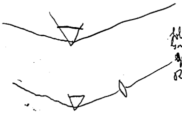


Bild sehr klein

$\frac{1 \text{ mm}}{3636}$

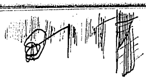


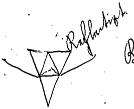
blau grün gelb rotes Ende

Bild des Spaltes

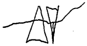
5 Minuten

~~[illegible]~~




Reflectirt

Brewster



Achromatie

Roth $\Delta_r = \gamma(n-1) - \gamma_1(n_1-1)$

$\Delta_g = \gamma(v-1) - \gamma_1(v_1-1)$

$\Delta_r - \Delta_g = \gamma(n-v) - \gamma_1(n_1-v_1)$

muß $= 0$ $\quad \dfrac{\gamma}{\gamma_1} = \dfrac{n_1-v_1}{n-v}$

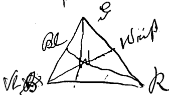
$\dfrac{n}{v} = \dfrac{n_1}{v_1}$

$\dfrac{n-v}{v} = \dfrac{n_1-v_1}{v_1} \quad \dfrac{v_1}{v} = \dfrac{\gamma}{\gamma_1}$

Royal ~~[illegible]~~ [illegible]

Absorption

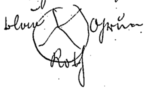
Farben Erscheinungen


G
Bl
Weiß
Vl ~~B~~
R

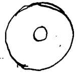
Farbentafel (Physiologisch)

~~Rot~~ für weiß

Scheiben zu Mischfarben

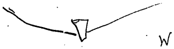

blau
Grün
Roth

July 31 1878



Kirchhof

Ultra Violet



Wärme
ultra Roth

Photographien

Aug 1

Fluorescirt   Netzhaut fluorescirt

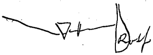
Wärme mehr zusammen Roth

Violet mehr zerstört

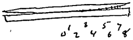
Lackmus roth

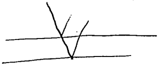
Licht ausgegossen über Spectrum. so Wärme

Absoluten Grenze



Interferenz





$$\frac{\lambda}{2} + 2n\frac{\lambda}{4}$$

$$R(1-\cos\omega) = 2R\sin^2\frac{\omega}{2}$$

$$\frac{R\omega^2}{2} = \frac{\lambda}{2}(1+n)$$

Na 50.000 Ringe